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July 1957

ARS-33-40

United States Department of Agriculture
Agricultural Research Service

SCREENING TESTS OF SOME ORGANIC INSECTICIDES AGAINST THE CALIFORNIA RED SCALE

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This report describes laboratory tests of various organic insecticides against the California red scale (Aonidiella aurantii (Mask.)) made at Whittier, Calif., from 1949 through 1955. The test compounds were from various sources and had preliminary screening in industrial or official laboratories. Most of them were phosphorus compounds. Our tests were designed to furnish the best indication possible of their effectiveness in the field as compared with parathion, a standard red scale insecticide.

In appraising the possibilities of field use of materials, toxicity to both scales and mammals must be considered. Parathion has about the upper limit of mammalian toxicity at the dosage recommended for use on citrus. Compounds that are less hazardous to handle than parathion were of special interest in these tests.

Experimental Procedure

Lemons were infested with scales in the laboratory and then kept in Henderson trays at 77° F. and 65 percent relative humidity until sprayed, within a few days after the scales began to reproduce. Most of the materials were applied with a pressure sprayer at 35 pounds per square inch according to a method previously described (Cressman 1). Each concentration was applied to two racks of eight lemons each. After they were sprayed they were removed to a lath house in order to minimize fumigation effects until mortality counts were made, which was about 8 weeks later unless development of the new generation necessitated an earlier count. About 75 scales from each lemon were examined to determine mortality.

During the time in the lath house reproduction and development of young proceeded except as inhibited by the residues on the lemons. Residual effects included reduction in the number of offspring as well as killing the young beneath the covering or after they emerged. Such

action is an important part of the total effect of many of the new materials. In the early part of the work lemons were inspected for such evidence of residual action. In later tests, if inspection indicated any appreciable action, some of the lemons on which mortality counts had been made were kept in the laboratory until female scales of the new generation became adults. The number of adults of the new generation in relation to the number of scales sprayed provided an index of the effect on the next generation. With the technique of handling fruit described by Munger and Broadbent (3), most of the lemons could be held in good condition for 5 to 6 months, the time required to complete a test in which residual action was measured.

When tests were made during the cool part of the year, mortality was determined on unsprayed checks and ranged between 2 and 5 percent. During the warmer season natural mortality could not be determined, as offspring would become adults and indistinguishable from the parent generation in the 8 weeks between spraying and mortality counts. Other studies, where the young scales were periodically removed, indicated that natural mortality was little greater in summer than in winter. It was not practicable to obtain a check on residual action by counting the offspring becoming adults on the unsprayed lemons. Other investigations, in which lemons were more lightly infested and young were periodically removed, showed that during most of the year one scale might produce 50 or more adult females in the absence of crowding. In the winter months productivity was less.

Tests with Wettable Powders

In the early work wettable powders supplied by the manufacturers were used, but after some data indicated that results were influenced by the formulation, the technical materials were obtained whenever possible and formulated in a standardized manner as wettable powders. Each compound was dissolved in a suitable solvent, usually acetone, slurried with a mixture of diatomaceous earth and clays, and dried on a steam bath to make a 25-percent wettable powder. Parathion wettable powder prepared in the same way was used as a standard. Results are shown in table 1, the materials being arranged in the order of their approximate toxicity.

Malathion was less effective than parathion in initial and residual toxicity, but it is much safer to use and is the only compound listed in table 1, other than parathion, that has come into commercial use on citrus. Its principal application has been as an additive to oil sprays, but it is sometimes used alone. In either case higher concentrations are required to equal the effect of parathion.

Diazinon showed sufficient toxicity to merit field trials in view of its moderate mammalian toxicity. Initial field experiments with a commercial wettable powder were disappointing, but laboratory tests indicated that more effective formulations could be made. More promising results were obtained in the field with a xylene solution containing 4 pounds of Diazinon per gallon with 4 percent of Atlas 1256 emulsifier applied at the rate of 0.75 pound of Diazinon per 100 gallons. Further field tests are under way.

Thimet was about equal to and Am. Cyanamid 12008 slightly better than parathion in both initial and residual toxicity. Their mammalian toxicity is comparable to that of parathion.

Para-oxon was the most toxic, relative to parathion, of the materials tested, but owing to its high mammalian toxicity field applications were not made.

Trithion and Guthion were less toxic than parathion to mature scales but about equal in residual effect. Since Trithion has been found effective against the citrus red mite, the possibility of controlling both scales and red mites with a single material merits thorough investigation. Its oral toxicity to mammals is less than that of parathion, and its dermal and vapor toxicities are very low.

The following materials showed little toxicity as compared with parathion at equivalent strengths. Unless otherwise indicated, the maximum strength at which these materials were used was 1 gram per liter.

Am. Cyanamid 4124 (0.36 gram)
Chlorophenyl benzenesulfonate
Chlorthion (0.72 gram)
DDVP
O,O-Diethyl N-ethoxycarbonylmethyl phosphoramidothioate
O,O-Diisopropyl phosphorodithioic acid ester of N,N-diethyl dithiocarbamic acid anhydrosulfide (Holcomb compound 326) (0.72 gram)
Dipterex (buffered with citric acid to maintain pH below 6)
Dow ET-15
Dow ET-57 (technical grade, sampled as ET-14)
EPN (0.36 gram)
Hercules AC-528
Kelthane
Strobane

Tests of Solutions and Emulsions

The results of the tests with materials applied in solutions or emulsions are presented below.

Milliliters/liter	Percent mortality	Milliliters/liter	Percent mortality
Schradan		Allethrin,	
1	39	3% in kerosene	
2	54	5	16
4	81	15	99
Kerosene		Sanorange	
5	16	10	12
15	94	20	2

Schradan was used in an aqueous solution, kerosene and the kerosene solution of allethrin were used in a tank-mix spray with blood-albumen spreader, and Sanorange was an emulsifiable solution of extracts of turpentine oil.

None of these materials showed any promise. Schradan, the most effective one, was much less toxic than parathion, as shown by comparison with results in table 1.

DDVP, ineffective as a wettable powder, was also tried in kerosene and kerosene-Arochlor mixtures, with little improvement in effectiveness. It showed some toxicity, but was definitely inferior to parathion. With this material mortality counts were made after 4 weeks.

Tests in Settling-Mist Chamber

One test--a comparison of an isoparaffinic fraction from petroleum oil with kerosene--was made in a settling-mist chamber or tower. A spray tower patterned after the chamber used in these tests was described by Ebeling (2, p. 298). The undiluted oils were applied, and the spray deposits measured on glass slides. Three sets of six lemons were included in each treatment. The isoparaffinic fraction had a narrower distillation range than the kerosene, and the average of the 15-, 50-, and 80-percent distillation points was 396° F. as compared with 426° for kerosene.

The results, given in table 2, show that the isoparaffinic petroleum fraction was more toxic than kerosene. Field tests were therefore made to compare it with an oil-parathion combination. Two gallons

of this fraction plus 0.2 pound of parathion per 100 gallons were much less effective than 1 gallon of light oil plus 0.2 pound of parathion against both scales and mites.

Literature Cited

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(2) Ebeling, Walter
1950. Subtropical entomology. 747 pp. Lithotype Process Co., San Francisco, Calif.

(3) Munger, F., and Broadbent, B. M.
1954. 2,4-D prolongs life of experimental lemons on the Henderson rearing racks. Jour. Econ. Ent. 47: 715.

Table 1.--Comparative toxicity of several organic insecticides and parathion to mature female California red scale and their residual effect when tested in wettable-powder sprays.

Test insecticide (gram per liter)	Percent mortality		Number of adult female offspring per sprayed female	
	Test insecticide	Parathion	Test insecticide	Parathion
Para-oxon				
0.36	72	49	1/	-
.72	86	-	1/	-
Am. Cyanamid 12008 2/				
0.25	75	56	0	0.3
.50	89	84	0.06	.3
1.00	91	-	.03	-
Thimet				
0.25	-	69	3/	2.3
.50	79	84	0.4	.3
1.00	89	-	.1	-
Malathion				
0.18	64	78	4/	-
.36	78	96	4/	-
Diazinon				
0.36	85	93	0.07	0.03
.72	93	99	.01	.001
Tetraisopropyl pyrophosphate				
0.36	28	49	4/	-
.72	51	-	4/	-
Trithion				
0.25	-	69	3/	2.3
.50	26	84	0.2	.3
1.00	41	-	.01	-
Guthion				
0.25	14	88	.02	.003
.50	28	95	.005	0
1.00	34	-	0	-

1/ Effective but not measured.

2/ 0.25 gram in September, 0.5 to 1 gram in July. Productivity was less after the September sprays because of lower temperatures.

3/ No significant residual action.

4/ Less effective than parathion.

Table 2.--Percent mortality of mature California red scales exposed to deposits of isoparaffinic petroleum fraction and kerosene.

Deposit (mg./sq. cm.)	Isoparaffinic fraction	Kerosene
72	11	-
150	87	36
218	92	78

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